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Mechanical Design of a 4.5kW High Speed Alternator

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Abstract :

A high speed permanent magnet alternator with a power rating of 4.5 kW at 30,000 rpm rated speed is indigenously developed for Gas Turbine Research Establishment (GTRE). An integrated test rig is designed and fabricated to demonstrate the performance of the alternator. The mechanical design of the alternator and the integrated test rig is presented in this report. The alternator mainly consisted of a rotor and a stator. The rotor is constructed with a cylindrical iron core, several magnets arranged circumferentially over the core and sleeve containment over the magnets in a concentric manner. The containment sleeve is the most critical component in the rotor assembly as it experiences very high circumferential stress resulting from the centrifugal loads of the magnets and its inertia due to high speed of rotation. A high degree of interference is required in the rotor assembly between the core, magnets and the sleeve in order to avoid slippage at high speed. A novel concept introduced relaxes the interference requirement and makes the assembly easier. Finite element analysis is carried out for the rotor by simulating interference and contacts between rotor core, magnet and the sleeve. The rotor shaft is supported at its ends using angular contact ball bearings with preloading spring. Critical speed analysis of the rotor is carried out and the first critical speed is well above the design speed. The performance of the alternator with an output of 4.5 kW power at 30000 rpm was successfully demonstrated.